

**Method for immersing an ultrasonic transducer in liquid metal, providing good wetting, and device for carrying out the method.**

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Classification EC : G21C17/08Brevets correspondants : DE3772271D,  FR2600201,  JP62299779Cited patent(s): FR1588441; GB1461944; FR2271581; FR1477470**Abrégé**

The transducer is introduced into a vessel (35) filled with inert gas. The coupling surface of the transducer (17) is brought into contact with a layer of liquid metal inside the vessel (35) and this layer of liquid metal is then solidified on the surface of the transducer. The transducer (17) with its solidified metal layer is introduced into the liquid metal (22). If impurities are present at the surface (18) of the metal (22) and if they are deposited on the transducer (17) they are then removed by melting of the solidified metal layer on this transducer. The invention applies in particular to an inspection of a sodium-cooled fast-neutron nuclear reactor.

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tact with the layer of liquid metal (45) under a neutral gas.

13. An immersion process according to claim 12, characterised in that the solidification of the layer of liquid metal (45) is effected in the enclosure (35) under a neutral gas and the transducer (17) is introduced directly from the enclosure (35) into the immersion liquid metal (22).
14. An immersion process according to either claim 12 or 13, characterised in that the casing (24) and the active part (25) of the transducer (17) are inserted separately in the enclosure (35), the active part (25) being inserted in the casing (24) within the enclosure (35).
15. A device for immersing in a liquid metal, whilst thoroughly wetting, an ultrasonic transducer (17) comprising a metal casing (24) enclosing the active part (25) of the transducer (17) and ensuring the coupling with the liquid metal (22) by a part (24a) of the outer surface of the casing, the liquid metal (22) having an upper free level (18) surmounted by an atmosphere of neutral gas (30), characterised in that said device comprises:
  - a glove box (35) whose interior volume communicates with the atmosphere of neutral gas (30) surmounting the free level (18) through an opening which is closable by a detachable wall (36);
  - a crucible (40) whose inside dimensions are slightly larger than the dimensions of the transducer (17), disposed inside the glove box (35);
  - and a cooling device (41) for cooling the crucible (40) placed in the glove box (35), the glove box (35) comprising means for putting its interior volume in communication with the atmosphere or for filling it with neutral gas.
16. A coating and immersion device according to claim 15, in the case where the transducer (17) is associated with an ultrasonic visualization device (2) in the vessel of a fast neutron nuclear reactor cooled by liquid sodium, said visualization device comprising a waveguide filled with a liquid metal having a low melting point and including, as the upper end part thereof, a container (15) located above the slab (1) of the reactor, characterised in that the glove box (35) is movably mounted onto the visualization device (2) above the slab of the reactor (1) and around the upper part of the waveguide of the visualization device surrounded by an atmosphere of inert gas (30).

### Patentansprüche

1. Verfahren zum Eintauchen eines Ultraschallwandlers (17) mit einer metallischen Hülle (24), die den aktiven Teil (25) des Wandlers einschließt und die Kopplung mit einer Metallschmelze (22) durch einen Teil (24a) ihrer Außenoberfläche sichert, in die Metallschmelze mit einer guten Benetzung, wobei die Metallschmelze (22) ein freies oberes Niveau (18) aufweist, über dem sich eine Atmosphäre aus neutralem Gas befindet, die durch Verunreinigungen verschmutzbar ist, die sich auf der Kopplungsoberfläche des Wandlers während dessen Eintauchens abscheiden und infolgedessen die Benetzbarkeit und die Güte der Kopplung dieser Oberfläche vermindern, dadurch gekennzeichnet,
  - daß man in einem unabhängigen Behälter (40) die Kopplungsüberfläche (24a) des Wandlers (17) mit einer dem Metall (22) analogen Metallschmelzeschicht (45) in Berührung bringt, in das man das Eintauchen des Wandlers vornehmen muß, um eine gute Benetzung der Kopplungsüberfläche durch die Metallschmelze zu bewirken,
  - daß man die Güte dieser Benetzung überprüft,
  - daß man die Erstarrung der Metallschmelzeschicht (45) auf der Kopplungsüberfläche des Wandlers hervorruft und
  - daß man unter neutraler Atmosphäre die Entnahme des auf der Kopplungsüberfläche erstarrte Metallschicht tragenden Wandlers aus dem Behälter (40) und seine Einführung in die Eintauchschmelze vornimmt.
2. Eintauchverfahren nach dem Anspruch 1, dadurch gekennzeichnet, daß man zum Sichern einer guten Benetzung der Kopplungsüberfläche (24a) des Wandlers durch die Metallschmelzeschicht die Hülle (24) des Wandlers und die Metallschmelze in Berührung mit dieser Hülle auf einer Temperatur über 300 °C vor Überprüfung der Benetzung hält, um die ggf. auf der Kopplungsüberfläche vorhandenen Oxide aufzulösen.
3. Eintauchverfahren nach dem Anspruch 1, dadurch gekennzeichnet, daß man vor ihrem Bringen in Kontakt mit der Metallschmelzeschicht auf der Außenoberfläche der metallischen Hülle (24) des Wandlers, die nicht den aktiven Teil (25) einschließt, wenigstens in ihrer Kopplungszone (24a) eine Oberflächenbehandlung durchführt, die wenig-

## Claims

1. A process for immersing in a liquid metal, whilst thoroughly wetting, an ultrasonic transducer (17) comprising a metal casing (24) enclosing the active part (25) of the transducer and ensuring the coupling with the liquid metal (22) by a part (24a) of its outer surface, the liquid metal having an upper free level (18) surmounted by an atmosphere of neutral gas liable to pollution by impurities which settle on the coupling surface of the transducer upon its immersion and thus reduce the wettability and the coupling quality of this surface, characterised in that:
 

the coupling surface (24a) of the transducer (17) is put in contact, in a separate container (40), with a layer of liquid metal (45) similar to the metal (22) in which the transducer must be immersed, so as to achieve a satisfactory wetting of the coupling surface by the liquid metal,

the quality of said wetting is checked,

the solidification of the layer of liquid metal (45) on the coupling surface of the transducer is brought about,

and the transducer carrying the layer of solidified metal on its coupling surface is removed from the container (40) and immersed in the liquid metal, under a neutral atmosphere
2. An immersion process according to claim 1, characterised in that, in order to ensure a satisfactory wetting of the coupling surface (24a) of the transducer by the layer of liquid metal, the casing (24) of the transducer and the liquid metal in contact with said casing are maintained at a temperature higher than 300°C before checking the wetting, so as to dissolve the oxides which may be present on the coupling surface.
3. An immersion process according to claim 1, characterised by carrying out a surface treatment, prior to the contact with the layer of liquid metal, on the outer surface of the metal casing (24) of the transducer which does not enclose the active part (25), at least in its coupling region (24a), said surface treatment comprising at least the maintaining of it a high temperature in a non-oxidising atmosphere followed by a coating under vacuum with a thin layer of a metal which is slightly oxidizable or has a low free enthalpy of formation of its oxides, and by inserting the active part (25) of the transducer in the casing (24).
4. An immersion process according to claim 3,

characterised in that the treatment of the outer surface of the metal casing (24) comprises, in succession:

5 a stoving under hydrogen at a temperature between 400 and 500°C,

a stoving under vacuum at a temperature between 400 and 500°C,

and a metallic coating by evaporation under vacuum (PVD process).

10 5. An immersion process according to claim 4, characterised in that the coating metal is one of the silver-gold-platinum group.

15 6. An immersion process according to either claim 4 or 5, characterised in that the layer of metal coating has a thickness of between 2 and 10 micrometers.

20 7. An immersion process according to claim 1, characterised in that the layer of liquid metal (45) similar to the metal (22) of the waveguide has a thickness of between 1 and 10 mm.

25 8. An immersion process according to claim 1, characterised in that the immersion liquid metal (22) is the sodium-potassium eutectic alloy NaK.

30 9. An immersion process according to any one of claims 1 to 8, characterised in that the coupling surface (24a) of the transducer (17) is put in contact with a liquid metal similar to the immersion liquid metal (22) by plunging the transducer in a crucible (40) containing the liquid metal, the crucible (40) being thereafter cooled to ensure the solidification of the metal (45), and the transducer (17) being thereafter removed from the crucible (40) with the solidified metal layer for immersion in the liquid metal (22).

35 10. An immersion process according to claim 9, characterised in that the crucible (40) is placed in a coiled hollow tube (41) through which a calorific fluid passes to cool and solidify the liquid metal.

40 11. An immersion process according to claim 9, characterised in that the crucible (40) is disposed in a Peltier effect cell to produce the cooling and the solidification of the liquid metal.

45 12. An immersion process according to any one of claims 1 to 11, characterised in that the transducer (17) is placed into an enclosure (35) in which its coupling surface (24a) is put in con-